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Design and Implementation of Chemical Management Platform Based on Computer Web Architecture

Lina Chen*, Hongmei Sun, Jianquan Fu

ShijiaZhuang University of Applied Technology, Shijiazhuang 050081, China
187280350@qq.com

A perfect and effective management platform for hazardous chemicals will help improve the management capacity of companies and regulatory authorities in the field, thereby to reduce the potential safety hazards caused by chemicals. The purpose of this paper is to build a Web-based distributed management platform for hazardous chemicals, which adopts the B/S architecture integrated with the MVC operation mode. In the first half of phase, a waterfall development mode is accessed, and in the second half of phase, an iterative development mode is used to design and develop the program. After design of the platform, company will have a trial run for 5 months. The findings show that the chemical management platform based on the computer Web architecture can seamlessly integrate the existing business processes of the company. After the platform is accessed, it will help company improve the efficiency of business processes by about 20%, so that the multifaceted supervision and control will be enabled for the regulatory authorities and companies. This study provides the clues to the successful and efficient development for hazardous chemical management model in China. It indeed has important practical significance.

1. Introduction

China is the third largest producer and importer of chemicals after the United States and Japan. With a production capacity of more than 45,000 kinds of chemicals, China has yielded more in chemical industry, accounting for 18.3% of total industrial output. In view of mass production and use, chemicals have infiltrated into various fields of people's daily life, greatly facilitating people, but bringing a catastrophic risk to environment and human health. Due to the complex properties and proliferation of hazard classes of some chemicals (Guillén-Gosálbez and Grossmann, 2000; Ali-Dahmane et al., 2016), the supervision and management of dangerous chemicals are more cumbersome and dangerous, which have always been highly concerned by many countries all over the world. However, in relation to foreign countries, the supervision, management, classification and relevant laws and regulations issued for hazardous chemicals in China are relatively lagging far behind. For the sake of safety in the production of hazardous chemicals, it is imperative to construct such a chemical management platform that should integrate more types of chemical safety information databases, and enable a smooth network inquiry.

The study of chemical management platform started earlier in the foreign countries, involving the production, transportation, warehousing, file management and other processes (Lasschuit and Thijssen, 2004). It has also gradually introduced computer-aided management mode, integrated with radio frequency and other advanced technologies in an attempt to realize the intelligent management for hazardous chemicals (Ferrio and Wassick, 2008). On the contrary, China starts relatively late in this field, but a certain progress has been made in the development and applications of products by introducing foreign technologies. However, there are still gaps such as lack of general and integrated tools or platforms, low efficiency of data retrieval, different standards for chemical safety management, and poor communication in the management process of dangerous chemicals for imports and exports (Belaud and Dupros, 2014).

Based on the above analysis, this paper uses the polygon evaluation method to compare the common B/S development technologies, selects the smart client as the application programs of the chemical management platform. The Web Service, Smart Client are adopted to develop the platform based on Microsoft .NET FrameWork. The design purpose of platform and its software and hardware designs are clarified in detail, and

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the module constitution, function partitioning of the platform are also described herein. Beyond that, the developed platform is put into service for a trial operation in the chemical industry. The operation results show that the platform can effectively improve the business process efficiency and enable easy multifaceted supervision for regulatory authorities and companies, so that it has a certain application value in the industry.

2. Technological background and platform software and hardware design

2.1 Common B/S development technology

Client, Internet, and smart client applications are several commonly used B/S development technologies (Puigjaner and Guillén-Gosálbez, 2008; Yang et al., 2017). Among which, smart client integrates the features of the first two clients. It fully uses local computer and network resources, allows easy offline operation, supports remote login and stand-alone work. Although the pre-development cost is high, it has convenient applications and lower maintenance cost in the late (Nikolopoulou and erapetritou, 2012). This paper uses the polygon evaluation method (Ilo et all, 2018) to evaluate the three methods, as shown in Figure 1, comprehensively considerate five factors, i.e. management, quality, experience, technology, quotation. Eventually, it is determined that a smart client is used as a platform application.

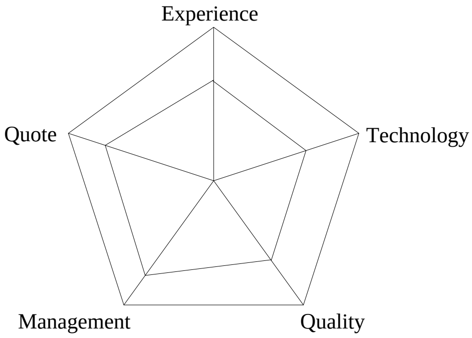

Figure 1: Polygon graph evaluation

2.2 Platform overview

The purpose of the platform design is to be in line with the international chemical safety management standards, integrate a series of key technologies from the inputs and outputs of raw material products to the order delivery, acceptance and other management processes (Berning et al., 2002). In order to ensure the stability of platform when multi-user concurrently accesses it, it integrates the Web Service, Smart Client based on Microsoft .NET FrameWork (Marendaz et al., 2011), no need to install it, user can log in it via the computer browser.

2.3 Design of platform software and hardware

2.3.1 Hardware

The platform hardware design involves the access to the head office, branch office and business trip or overseas subsidiaries. Among them, the personnel in head office can access the web server set up in the head office via the LAN; the branch office accesses it via the VPN, and the business trip or overseas subsidiaries can access it via the Internet. For the sake of safety, the latter two cases are not allowed until they are authenticated by the firewall.

2.3.2 Software

The platform adopts the MVC design mode to partition the input, output and processing programs required for it into three levels: view, application and control levels (Oh and Karimi, 2004). As shown in Figure 2, there are the relationships between the three and their respective main functions.

The view layer uses Web application development to implement an interface that interacts with the users (Achichi et al., 2016; Reiskin et al., 2010), but it is only limited to the user request and the data collection and treatment on the view. Model design, as the core of MVC, is responsible for developing the business rules, receiving request data for views, dealing with business processes, and feeding back the final results to the view level (Teimoury, et al., 2010). The control level is not responsible for processing business information. It can be described as a megaphone role which delivers the information required by the user to the model, informing the model to select the view required by the user and return to the user.

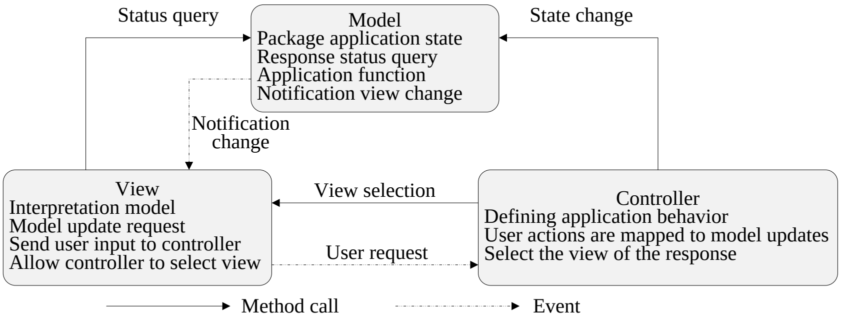

Figure 2: MVC model

3. Design and implementation of dangerous chemical management platform

3.1 Module division

As shown in Figure 3, there are the module levels in the hazardous chemical management platform designed as required by the management of hazardous chemicals. The upper module is the user operation interface, the bottom module provides data it required, and the middle module implements the management, supervision and other business functions for hazardous chemicals in the platform via the user operation interface.

Hazardous Chemicals Management Platform Module Level	
Upper module	User interface
Intermediate module	User management module、Business process management module 、Chemical information management module、Chemical data report module
Underlying module	Database operation、Log management ••• Basic common function

Figure 3: Dangerous chemical management platform module level

3.2 Function description for business modules

3.2.1 Platform login

Since data viewed by different users are different, the user should first enter his/her own username and password for authentication to obtain appropriate information as desired, the system will automatically load the appropriate function modules according to the user's permission on successful authentication. Otherwise, the user won't be allowed to log in the platform, as shown in Figure 4, it is the branch of platform business modules, and Figure 5 is the platform login interface.

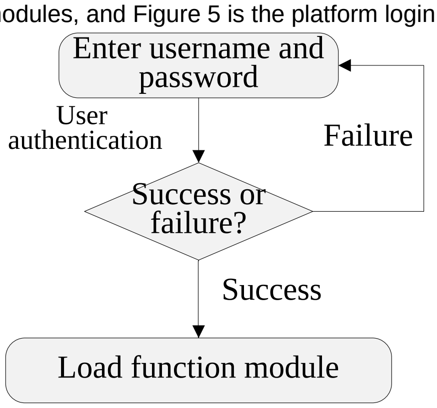

Figure 4: Business module branch

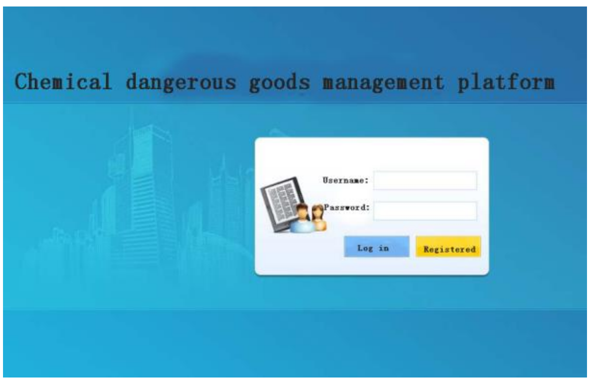

Figure 5: System login interface

After logging in the platform successfully, enter the main interface of the dangerous chemical management platform, as shown in Figure 6, there is the menu tool of the platform on the left side, after clicking the menu name, the corresponding sub-function will appear on the right side.

Figure 6: Main interface of chemical dangerous goods management system

3.2.1 Chemical information management module

This module starts from the input of a single chemical information, and after continuous modification, ends up with determining hazard components of chemicals. It, as a key part for displaying the details of basic data of all chemicals, provides a basis for how to review and accept hazardous chemicals. As shown in Fig. 7, there are the sub-functions of the chemical information management module, including the chemical hazard information maintenance, list of components and auxiliary functions.

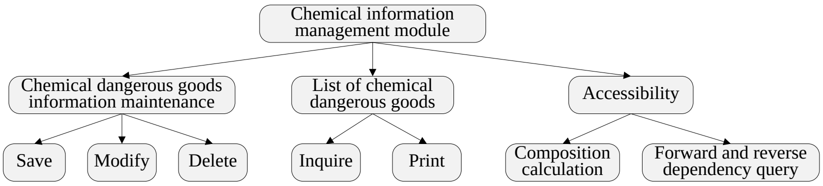

Figure 7: Chemical information management sub-function

(1) Hazardous chemical information maintenance, it includes three sub-functions, i.e. saving, modifying and deleting. The saving function is to originally input the information about hazardous chemicals, including two parts: temporary saving and final saving. Only when data is finally saved can it enter the review state and become a part of management of hazardous chemicals, see Figure 8 for its process flow. The information modification and deletion are indispensable operations during the information maintenance for hazardous chemicals.

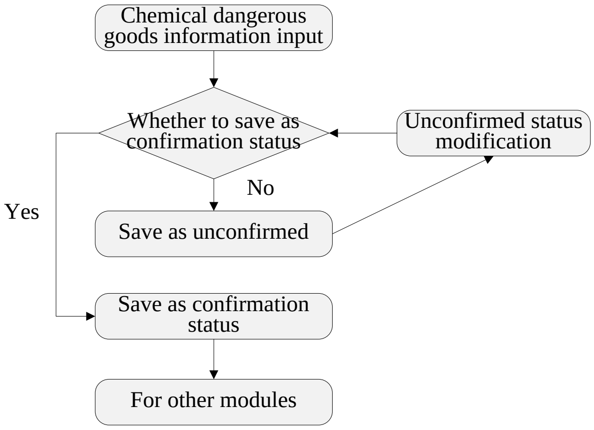

Figure 8: Chemical dangerous goods composition preservation process

(2) List of chemical components, Due to the wide variety of hazardous chemicals, it is more awkward to find a specific information. Some retrieval criteria such as keywords, tags, categories, etc. are designed for searching data information about such chemicals. After the information to be retrieved is input on the platform, the list of retrieval hits with print function will appear on the platform for users to query, which can greatly save the search time.

(3) Aided function, In addition to the last two functions, the platform provides an operation function for the hazardous chemical components and also two-way query based on the chemical composition or chemical information.
(4) Business process management module, as shown in Fig. 9, it is the basic class of the business process management module. As for the specific treatment and verification procedures, it is required for the company to call them after implementing the ICommand interface according to its inhouse situation.
(5) Chemical data report module, To reduce the workload of the staff and improve their work efficiency, the module adopts report data acquisition, combination and display structure (Comber et al., 2013), and divides report data into company reports, dangerous chemicals reports and combination report of the two. See Figure 10 for the basic classes of the report data modules.

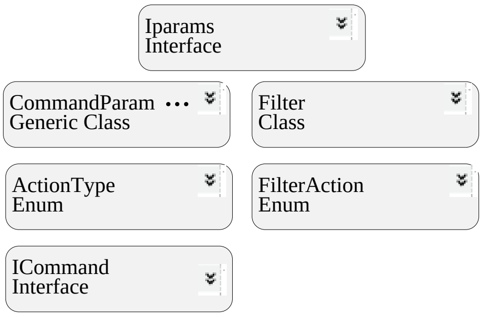

Figure 9: Business Process Management Module Basic Class Diagram

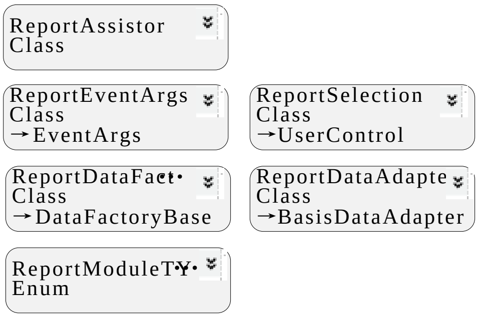

Figure 10: Chemical data report module basic class diagram

3.3 Platform application results

3.3.1 Improving efficiency

Figure 11 gives a comparison of the number of dangerous chemicals before and after the use of the platform. As shown in the figure, the number of dangerous chemicals processed in each quarter after using the platform is about 20% higher than that before the use, especially in the second quarter which is a peak season for using the dangerous goods. On this basis, it can be speculated that when the platform is used proficiently, the number of processing chemicals will be greatly increased.

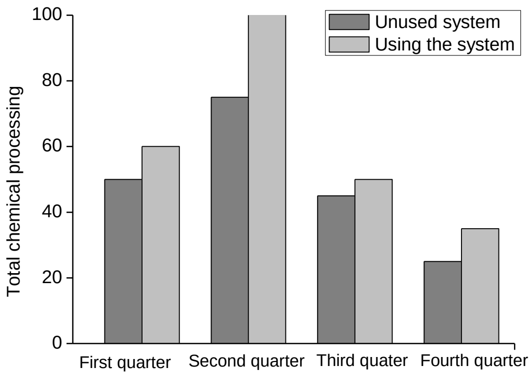

Figure 11: Before and after the system use comparison chart

3.3.2 Multi-faceted supervision

Company managers can directly understand the basic information such as the order and its use of hazardous chemicals via the management platform, so as to facilitate the overall control and management of the business situation involving hazard chemicals in the company. With the WAN as built, whether for the company managers or other regulatory departments, it can allow inquiry and supervision on the information of dangerous chemicals whenever and wherever possible.

4. Conclusion

The effective chemical management platform is very important to improve the management capacity for hazardous chemicals in chemical industry and relevant corporations. For this purpose, this paper takes a deep

dive into the design and implementation of chemical management platform based on computer Web architecture. The specific conclusions are given as follows:
(1) The comparative analysis is made for the common B/S development technologies to determine application of the smart client as a platform and the hardware architecture of the platform. MVC is used to design the system software.
(2) As required by the corporations, the partitioning of platform functions and the composition of platform modules are described in detail, and the specific functions of each module are designed and implemented.
(3) Chemical management platform designed is put into service in the chemical companies for pilot run. The results show that the platform has improved business efficiency by about 20% compared with the original ones, and also enables multifaceted supervision and control by regulatory authorities and corporations.

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